

Atty. Docket No. SPO200512-0108US
Application No: 10/761,500

Remarks

Applicant and his representatives wish to thank Examiner Blan for the thorough examination of the present application and the detailed explanations in the Office Action dated May 31, 2007. Claims 1, 7-12, and 14 have been amended. Claims 2, 3, 13, and 19-25 have been canceled. New claims 26-33 have been added. Therefore, claims 1, 4-12, 14-18, and 26-33 are active in this application. No new matter is introduced by the present Amendment.

The present invention relates to a method for cleaning a semiconductor substrate having an etched pattern of lines or trenches thereon or therein, comprising the steps of:

- (a) cooling a cleaning solution comprising a mixture of deionized water, sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF) to a predetermined temperature lower than ambient or room temperature; and
- (b) supplying the cooled cleaning solution to the semiconductor substrate to remove etch by-products from the pattern of lines or trenches (see amended claim 1 supra).

Claim 12 contains similar language.

The cited references do not disclose, teach, or suggest, alone or in combination, a method for cleaning a semiconductor substrate having an etched pattern of lines or trenches thereon or therein that comprises cooling a cleaning solution comprising a mixture of deionized water, sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF) to a predetermined temperature lower than ambient or room temperature. Thus, the present claims are considered patentable over the cited references.

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The Objection to Claims 8 and 18

The objection to claims 8 and 18 has been obviated by appropriate amendment in part, and traversed in part.

Each of the members of the group recited in claim 8 has been recited in a separate dependent claim (see amended claim 8 and new claims 28-31).

Claim 18 contains the same limitations as claim 11 to which no objection is made. In addition, claim 18 does further limit the subject matter of a previous claim. Claim 18 states that the etched metal pattern of claim 12 comprises a conductor selected from the group consisting of aluminum, an aluminum alloy, copper, a copper alloy, tungsten, a metal silicide layer, and a barrier metal layer. The etched metal pattern of claim 12 is not limited to the conductors recited in claim 18. Thus, claim 18 further limits the subject matter of claim 12.

Therefore, withdrawal of this objection is earnestly requested.

The Rejection of Claims 1, 4-9, 11-12, 16 and 18 under 35 U.S.C. § 103(a)

The rejection of claims 1, 4-9, 11-12, 16 and 18 under 35 U.S.C. § 103(a) as being unpatentable over Aoki et al. (US 6,387,190; hereinafter, "Aoki") in view of Chang (US 6,423,147) is respectfully traversed.

Aoki discloses a method for cleaning a semiconductor wafer after chemical mechanical polishing a copper wiring, using washer (fluid) that contains a decontaminating agent selected from polycarboxylic acid, ammonium salts thereof and polyaminocarboxylic acid (Abstract). Aoki further discloses spraying an aqueous solution containing hydrofluoric acid and hydrogen peroxide onto surfaces of samples of a semiconductor structure during the rotation of the samples (col. 9, ln. 66 – col. 10, ln. 12). However, Aoki appears to be silent with respect to a cleaning solution comprising sulfuric acid (H₂SO₄) with other components, as recited in present claims 1 and 12. Thus, Aoki is saliently deficient with respect to the present claims 1 and 12.

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Chang discloses a method of removing small particles remaining on a surface of a semiconductor wafer and preventing a silicide layer covering the semiconductor wafer from corrosion by utilizing a cleaning solution comprised of hydrogen peroxide (H_2O_2), ammonia (NH_4OH), and deionized water at a temperature between 0 °C and 45 °C (Abstract). However, Chang also appears to be silent with respect to a cleaning solution comprising sulfuric acid (H_2SO_4) with other components, as recited in the present claims 1 and 12. Thus, Chang fails to cure all of the deficiencies of Aoki with respect to the present claims 1 and 12.

As a result, no combination of Aoki and Chang disclose, teach, or suggest cooling a cleaning solution comprising a mixture of deionized water, sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF) to a predetermined temperature lower than ambient or room temperature, as recited in the present claims 1 and 12. Claims 4-9 and 11 depend from claim 1 and are patentable over Aoki and Chang for at least the same reasons as claim 1. Claims 16 and 18 depend from claim 12 and are patentable over Aoki and Chang for at least the same reasons as claim 12. Therefore, this ground of rejection is unsustainable, and should be withdrawn.

The Rejection of Claims 2, 3, and 13-15 under 35 U.S.C. § 103(a)

The rejection of claims 2, 3, and 13-15 under 35 U.S.C. § 103(a) as being unpatentable over Aoki and Chang and further in view of Konishi et al. (US 6,227,212; hereinafter, "Konishi") is respectfully traversed.

As discussed supra, no combination of Aoki and Chang disclose, teach, or suggest cooling a cleaning solution comprising a mixture of deionized water, sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF) to a predetermined temperature lower than ambient or room temperature, as recited in the present claims 1 and 12. Konishi fails to cure all of the deficiencies of Aoki and Chang.

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Konishi discloses a semiconductor workpiece cleaning apparatus comprising means for cleaning a semiconductor workpiece by using a cleaning liquid, means for charging a drying liquid, and means for discharging the cleaning liquid (Abstract). Konishi further discloses that the cleaning liquid may be one or more of eight different mixtures, encompassing 255 different possible compositions (col. 5, ln. 59 – col. 6, ln. 5). Of the eight listed mixtures, only one includes sulfuric acid (H_2SO_4), but it does not include hydrofluoric acid (HF). Three of the other mixtures in the list of eight include hydrofluoric acid (HF), but they do not include sulfuric acid (H_2SO_4).

Thus, Konishi does not affirmatively disclose a cleaning solution comprising a mixture of deionized water, sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF), as recited in present claims 1 and 12, nor does Konishi provide any motivation or reason to select the one mixture containing sulfuric acid (H_2SO_4) and combine it with one or more of the three mixtures containing hydrofluoric acid (HF).

The Federal Circuit has noted that although claims may be subsumed in a reference's generalized disclosure, this is not necessarily literal identity. *Minnesota Mining & Manufacturing Co. v. Johnson & Johnson Orthopaedics, Inc.*, 976 F.2d 1559, 1572, 24 USPQ2d 1321, 1332 (Fed. Cir. 1992) (no anticipation was found because "ranges [of the prior art reference]... are 'so broad as to be meaningless to one skill in the art'"). Since Konishi discloses that the cleaning liquid may comprise any composition of one or more mixtures from a list of at least eight different mixtures (col. 5, ll. 59-67), the disclosure of Konishi is so broad as to be meaningless to one skilled in the art with regard to selection of a certain combination of chemical compounds (i.e., deionized water, sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF)) as recited in the present claims 1 and 12.

In determining obviousness, one must consider whether one of ordinary skill in the art would be motivated to combine known elements to arrive at a claimed combination. This inquiry includes, but is not limited to, an examination of the teachings, suggestions, or motivations of the patentees of the prior art cited by the Examiner. *KSR Intern. Co. v. Teleflex*

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Inc., 127 S.Ct. 1727, 1742 (U.S. 2007). Neither Konishi nor either of the other cited references (Aoki and Chang) provide any motivation for using the particular combination of deionized water, sulfuric acid (H₂SO₄), hydrogen peroxide (H₂O₂), and hydrofluoric acid (HF) to remove etch by-products from a pattern of lines or trenches. Thus, Konishi fails to cure all of the deficiencies of Aoki and Chang with respect to the present claims 1 and 12.

As a result, no combination of the cited references discloses, teaches, or suggests cooling a cleaning solution comprising a mixture of deionized water, sulfuric acid (H₂SO₄), hydrogen peroxide (H₂O₂), and hydrofluoric acid (HF) to a predetermined temperature lower than ambient or room temperature, as recited in the present claims 1 and 12. Claims 14 and 15 depend from claim 12 and are patentable over the cited references for at least the same reasons as claim 12. Therefore, this ground of rejection is unsustainable, and should be withdrawn.

The Rejection of Claims 10 and 17 under 35 U.S.C. § 103(a)

The rejection of claims 10 and 17 under 35 U.S.C. § 103(a) as being unpatentable over Aoki and Chang and further in view of Cathey, Jr. (US 5,185,058; hereinafter, "Cathey") is respectfully traversed.

As discussed supra, no combination of Aoki and Chang disclose, teach, or suggest cooling a cleaning solution comprising sulfuric acid, much less a mixture thereof with deionized water, hydrogen peroxide (H₂O₂), and hydrofluoric acid (HF), as recited in the present claims 1 and 12. Cathey fails to cure all of the deficiencies of Aoki and Chang.

Cathey discloses a process for etching a semiconductor device to form a predetermined etched pattern therein (Abstract). However, Cathey appears to be silent with respect to a cleaning solution comprising sulfuric acid, much less a mixture thereof with deionized water, hydrogen peroxide (H₂O₂), and hydrofluoric acid (HF), as recited in the present claims 1 and 12. In fact, Cathey appears to be silent with respect to any method for cleaning a semiconductor

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substrate or an etched metal pattern. Thus, Cathey fails to cure any of the deficiencies of Aoki and Chang with respect to the present claims 1 and 12.

As a result, no combination of the cited references disclose, teach, or suggest cooling a cleaning solution comprising a mixture of deionized water, sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and hydrofluoric acid (HF) to a predetermined temperature lower than ambient or room temperature, as recited in the present claims 1 and 12. Claim 10 depends from claim 1 and is patentable over the cited reference for at least the same reasons as claim 1. Claim 17 depends from claim 12 and is patentable over the cited references for at least the same reasons as claim 12. Therefore, this ground of rejection is unsustainable, and should be withdrawn.

Conclusions

In view of the above amendments and remarks, all bases for objection and rejection are overcome, and the application is in condition for allowance. Early notice to that effect is earnestly requested.

If it is deemed helpful or beneficial to the efficient prosecution of the present application, the Examiner is invited to contact Applicant's undersigned representative by telephone.

Respectfully submitted,



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